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HAKE RECRUITMENT IN THE SOUTHERN STOCK (ICES DIVISIONS VIIIc AND IXa).

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ABSTRACT

Spatial distribution and year class strength for hake in the Southern Stock (ICES Divisions VIIIc and IXa) are analysed from historical series from spanish bottom trawl surveys (1980-1990). A nursery ground in the continental shelf of the northern coast of the Iberian peninsula is compared with the recruitment in adjacent areas (Portuguese and French waters).

INTRODUCTION

The distribution area of the species Merluccius merluccius is in the waters between the African coast off Morocco and the North Sea. Nevertheless for purposes of evaluation the area is considered to be divided into two stocks, Southern and Northern Stocks with the underwater canyon of Cap Breton as a common border, situated between ICES Divisions VIIIc and VIIIb. The hake working group considered, in its first meetings, one single stock (ANON, 1969 and 1973), but since 1979 the two stocks have been considered separately (ANON, 1979 and 1980).

Still recognising the non-existence of clear biological bases, one of the criteria followed was that based on the presence of two nursery grounds, one of them on the coasts of France (GUICHET *et al*, 1974 and GUICHET, 1977) which would support the Northern stock, and the other on the coasts NW of the Iberian peninsula (LOPEZ VEIGA et al, 1977; PEREIRO et al, 1980 and PEREIRO and FERNANDEZ, 1983), supporting the Southern stock.

With the objective of monitoring these concentrations of hake recruits, the Instituto Español de Oceanografía has, since 1980, conducted bottom trawl surveys in the Southern Stock hake nursery grounds.

In the present work a description is made of age 0 hake concentrations in divisions VIIIc and IXa and their evolution during the period from 1980 to 1990.

METHODOLOGY

The vessel used in prospecting, the gear used, the sampling design and the characteristics of fishing operations, have already been described in previous works (PEREIRO and PIÑEIRO, 1985; ANON, 1989; ANON, 1991 and SANCHEZ *et al*, 1991).

In table 1 the number of hauls made per depth stratum and geographical sector of the survey is summarised for each year. As an indication of the coverage reached the number of squares in each sector/stratum (5*5 nautical miles) is also indicated. It must be pointed out here that the coverage was incomplete in the years 1980, 1981 and 1982, though the prospected zone covered the most important areas and bottoms. In the survey in 1989, the meteorological conditions reduced the coverage of the stratum 201-500 m, a fact which has affected the results of that year. Figure 2 shows the fishing gear used as sampler and figure 3 the stratification used in the surveys. As a sample, the distribution of hauls in the 1990 survey throughout the continental shelf can be seen, although due to the coverage reached and the trawling grounds, the picture would be similar in any of the other years.

To map the results and to be able to evaluate tendencies in spatial distribution of the age 0 class, a geostatistical method has been used (MATHERON, 1971; CLARK, 1979; CONAN, 1985). PETITGAS and POULARD (1989) applying this methodology in Northern Stock hake recruitment on the French continental shelf with promising results. Our sampling strategy is not the most appropriate for this technique due to the random distribution of the stations giving rise to large gaps and provoking high variances in the kriging. To obtain better results in the tracing of density isolines through the use of kriging it would be necessary to increase the established depth limits, or to make a systematic sampling to avoid possible bias in the interpolation. Nevertheless, the high percentage of stations sampled per unit surface in our surveys permits us to make estimations about the spatial structure of the existing aggregations and to locate them spatially. To do this experimental variograms have been obtained each year and from the values of the adjusted spherical model, and using the kriging technique we obtained the density contours of the abundance of recruits for the area studied. The treatment of the information with this methology has been done using the software GEO-EAS (ENGLUND and SPARKS, 1988).

RESULTS AND DISCUSSION

Table 2 and figure 5 summarise the results of the abundance indices of hake recruits obtained in the series of surveys in the period 1980-1990. Hake recruits of age 0 have been considered as all individuals which, at the time of the survey (September-October), were less than 17 cm in length. The reason for using this limit is due to the difficulties of interpreting the otoliths of this species, and because of this the size compositions obtained in the survey were analysed. In figures 4, 5 and 6, the size distributions by zone and year are presented. As can be seen in table 2, in the areas of greater recruit abundance (IXa2 and VIIIc1) an isolated mode appears, distributing individuals in a range from 5 to 16 cm. The repetition of such a marked phenomenon throughout the series suggests that it corresponds to an age class which we identify as 0.

In Subdivision VIIIc2 where the presence of recruits is much lower the picture is not so clear, with several age groups overlapping and making the separation into components difficult. The relative importance of this can be analysed in figure 7, in which the distribution and abundance of individuals smaller than 17 cm (age 0), larger than 17 cm (more than 1 year) and the yields of the species expressed in biomass (kg/30 min. haul) are presented. Thus, it can be seen how the recruits are mainly concentrated on the NW edge of the Iberian peninsula, their presence reducing as we move to the south or to the east. If we refer to the geographical distribution of individuals older than 1 year, these are mainly found in waters close to Division VIIIb. The biomass yields in figure 4 show how the large number of examples from Subdivisions IXa2 and VIIIc1 offset the higher weight of the adults found in VIIIc2.

The evolution of the indices in the period studied does not indicate the clear tendency of abundance with time, showing a sequence of ups and downs. What it does express is how the recruits concentrate at this time of year, in the recruitment area where all of the examples are considered to be recruited (PEREIRO et al, 1980) in waters of between 100 and 200 m depth. Once again we call attention to this point as covered in the methodology section, that the strongly marked peak appearing in 1989 in the stratum 201-500 m must be considered with some reservation because of the problems in sampling in that year and that stratum mentioned in the previous section. The indices also appear to corroborate that the areas of highest abundance are Divisions IXa2 and VIIIc1.

From the data obtained in the 1990 survey an experimental variogram has been made which clearly manifests a strong spatial correlation of data (fig. 8). The adjustment of the spherical model gives us a range of 50 km for spatial effects and an absence of nugget effect. This spatial dependence structure remains stable, with slight differences in the rest of the years studied, which has been used in each case to map the density contours through the use of the kriging technique. Finally, to analyse the presence of spatial anisotropy in the aggregations, a study has been made using data from the area of higher recruitment during 1990 (VIIIc1). The results show a different spatial structure, depending on the angle considered (fig. 8), brought on by a greater effect of the limiting factors according to the analysis made perpendicularly to the continental shelf (135° - range 30 km) with respect to that made longitudinally to the same (45° - range 50 km).

The maps resulting from the application of this methodology are presented in figures 9, 10 and 11. On the one hand it can be seen how abundances differ from some years to others, and on the other a certain contraction seems to be observed in the size of the distribution area through time. Analysing the figures, two principle concentrations can be seen, one of them situated in Subdivision VIIIc1 and the other in IXa2. Another, smaller grouping always appears in Subdivision VIIIc2, bordering on Subdivision VIIIc1. Each year the abundance in each aggregation depends on the annual strength of recruitment, but if we compare the concentrations with each other, we see how the relative importance of Subdivision IXa2 diminishes with time with respect to Subdivision VIIIc1, a great concentration tending to appear in the latter area and being almost insignificant to the south and east of this area.

Some other data appears to corroborate this tendency of the concentrations of recruits in the south of the area to diminish, to concentrate more in the north. LOPEZ VEIGA <u>et al</u>, (1976) identify two principle areas of aggregation (VIIIc1 and IXa2) of individuals of age 0 in Galician waters, the most important being located further south (IXa2). In more recent times and adding to this theory, the results of Portuguese surveys to estimate abundance indices of recruits (ANON, 1989), indicate that in 1981 concentrations of class 0 individuals in Subdivision IXa1 are at a maximum in the area in the proximity of Subdivision IXa2 and of similar intensity. In 1982 they continue to be important, though less so, and in later years are very low or practically non-existent.

If we now compare our results with the recruitment tendencies of the Northern Stock from French and British surveys (ANON, 1988, 1989 and 1990) in the same period, they indicate that in 1985 the recruitment indices were high, in 1986 very low and at average values during the rest of the period. This tendency does not correspond to the Southern Stock, in which Spanish survey results point to 1984 as the year of the highest indices in the series and 1985 as that of the lowest. These differences in the tendencies in one area or another can be explained by the different environmental conditions, which may have provoked the succes or failure of the spawning. This would imply that the recruitment process has been produced in an independent way.

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Depth str / geogr str	30-100 4	5	6	101-200 1	2	3	4	5	6	201-500 1	2	3	4	5	6	Total
Squares	8	17	15	29	32	16	21	34	16	11	30	0	7	15	9	260
Year	hauls			hauls						hauls						hauls
80	-	-	-	10	13	-	-	-	-	-	-	-	-	-	-	23
81	-	-	-	11	11	-	-	-	-	2	2	-	-	-	-	26
82	-	-	-	14	13	7	-	-	-	-	-	-	-	-	-	34
83	3	3	2	12	15	9	11	14	6	3	8	-	5	10	6	107
84	2	2	2	14	17	8	6	9	3	5	12	-	2	9	4	95
85	2	2	4	14	16	8	5	10	5	5	15	-	2	6	3	97
86	2	3	4	14	15	2	6	11	6	5	14	-	2	5	3	92
87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
88	3	4	4	14	16	8	7	11	6	5	12	-	4	5	2	101
89	3	4	4	14	15	8	7	10	5	5	6	-	3	5	2	91
90	3	5	5	14	16	8	10	16	9	5	15	-	4	6	4	120

Table 1.- Squares (5*5 miles) and hauls in each survey.

Subdivision IXa2

STRATA -> YEAR	30-100 m Yst	Syst	101-200 m Yst	Syst	201-500 m Yst	Syst	Total Yst	Syst
80	-	-	254	49.5	-	-	254	49.5
81	-	-	1163	249.8	463	463.0	971	221.4
82	-	-	910	121.7	-	-	910	121.7
83	-	-	905	327.9	43	42.3	668	238.0
84	-	-	2540	556.8	1077	734.2	2138	451.4
85	-	-	354	91.3	79	40.6	278	67.1
86	-	-	1022	447.9	593	443.2	904	346.8
87	-	-	-	-	-	-	-	-
88	-	-	993	258.0	80	76.4	742	188.3
89	-	-	1059	285.6	490	240.1	903	217.3
90	-	-	198	43.0	48	39.3	157	33.0

Subdivision VIIIc1

80	-	-	668	149.2	-	-	668	149.2
81	-	-	1346	208.3	624	544.0	997	284.3
82	-	-	1660	347.4	-	-	1660	347.4
83	-	-	787	137.5	105	62.8	457	77.2
84	-	-	1840	359.8	261	117.1	1076	194.1
85	-	-	298	106.9	295	101.5	297	73.9
86	-	-	1195	333.9	14	5.9	624	172.4
87	-	-	-	-	-	-	-	-
88	-	-	2755	828.4	268	169.3	1552	435.4
89	-	-	2337	233.9	2816	1093.	2569	542.3
90	-	-	492	87.2	108	44.5	306	49.9

Subdivision VIIIc2

83	168	57.9	279	63.2	10	8.3	198	37.8
84	179	175.0	445	185.3	17	12.2	294	111.2
85	189	107.8	127	33.2	17	6.5	121	32.9
86	656	365.8	197	84.9	2	1.4	275	103.7
87	-	-	-	-	-	-	-	-
88	431	177.0	567	214.7	12	8.2	424	126.4
89	356	183.1	290	66.9	3	2.0	250	59.2
90	106	46.6	84	19.1	1	0.4	73	15.8

TOTAL

83	168	57.9	512	80.0	55	27.2	332	47.1
84	179	175.0	1157	172.7	281	122.4	764	107.4
85	189	107.8	208	35.2	142	42.8	187	28.6
86	656	365.8	574	124.1	97	67.8	455	92.3
87	-	-	-	-	-	-	-	-
88	431	177.0	1124	224.9	129	71.6	742	132.4
89	356	183.1	883	85.1	1249	456.8	904	138.3
90	106	46.6	195	23.5	53	19.5	142	16.1

Table 2.- Hake recruitment indices (Ind. < 17 cm / hour).

CLASSICAL BOTTOM TRAWL TYPE BAKA 43.6/60.1
Spanish Bottom Trawl Surveys

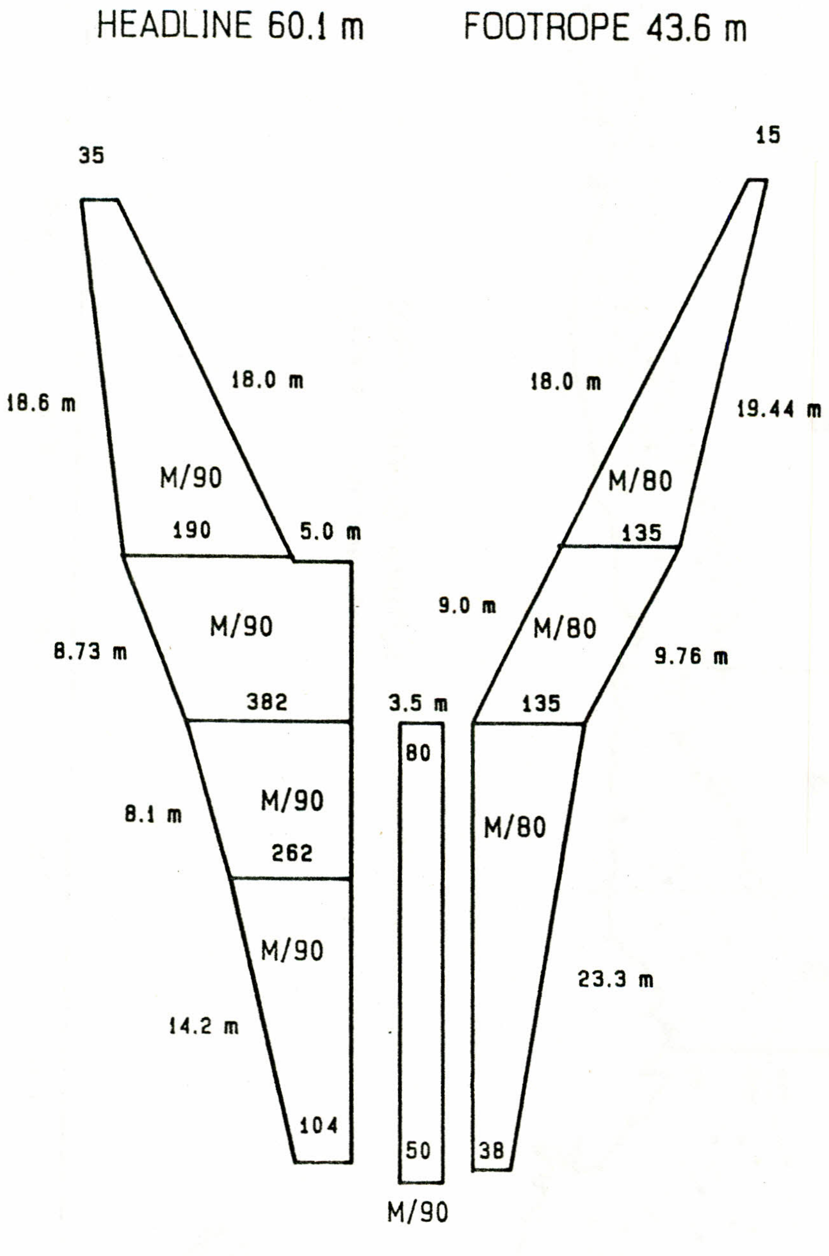


Figure 1.- Trawl gear used in the surveys.

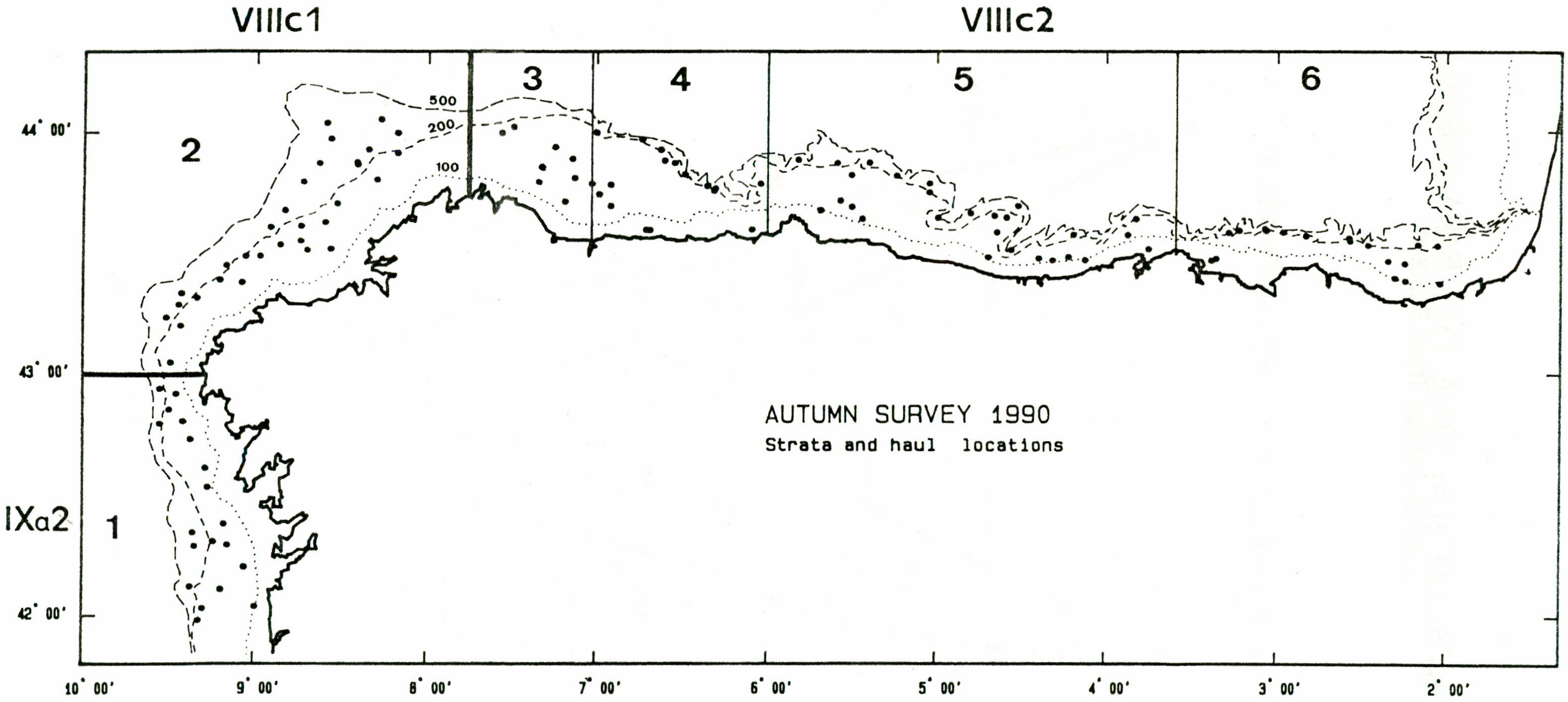
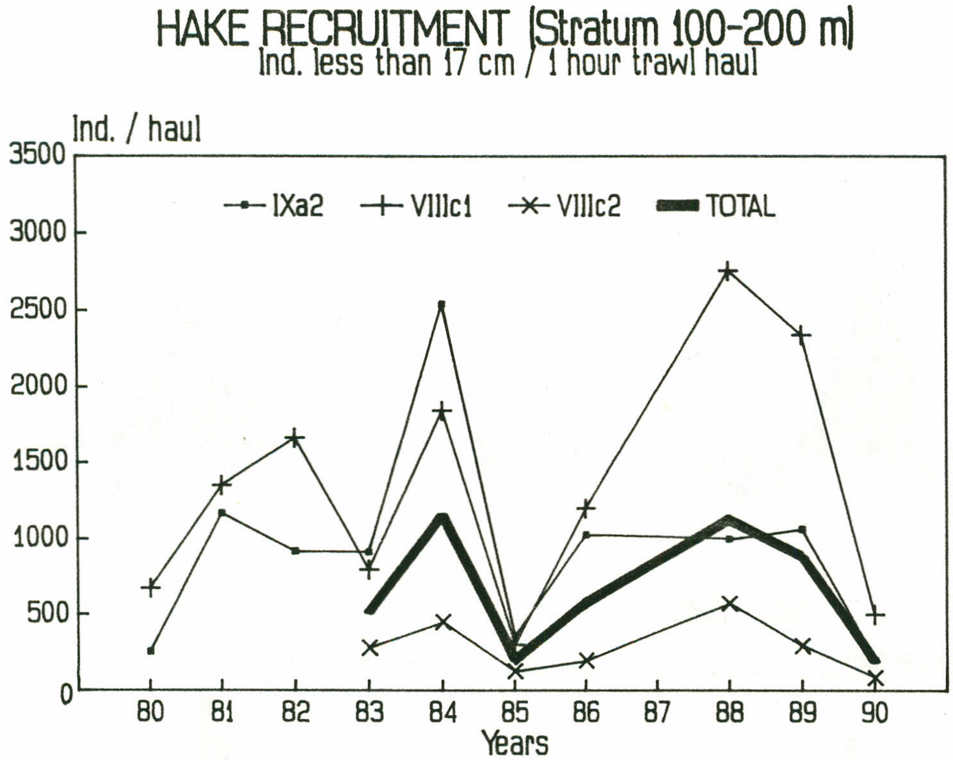


Figure 2.- Area studied and survey cover during 1990.



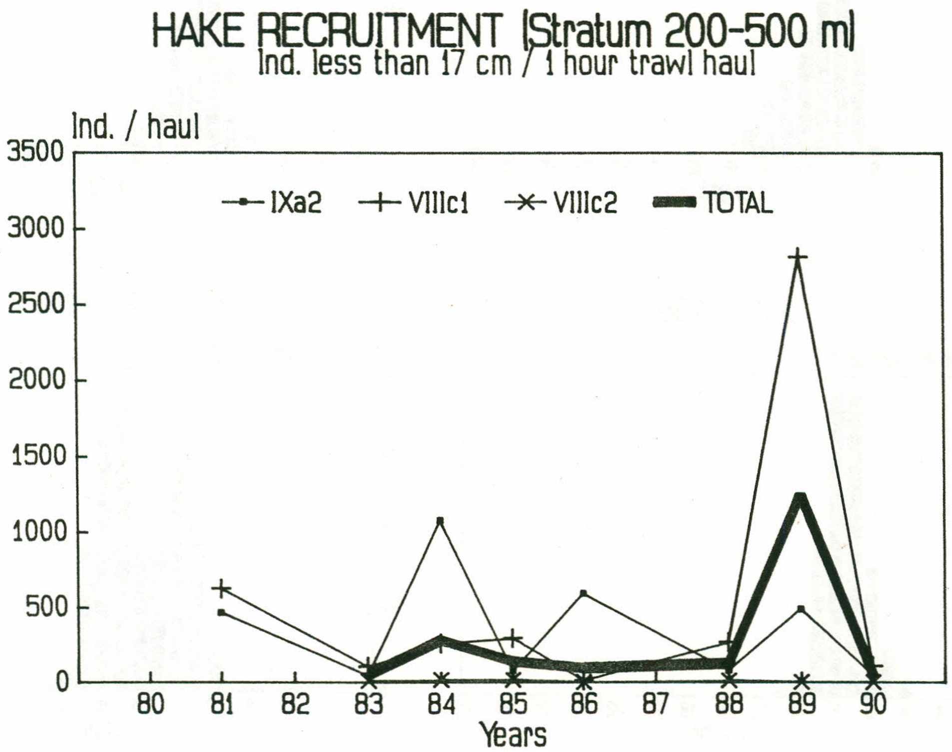


Figure 3.- Hake recruitment indices.

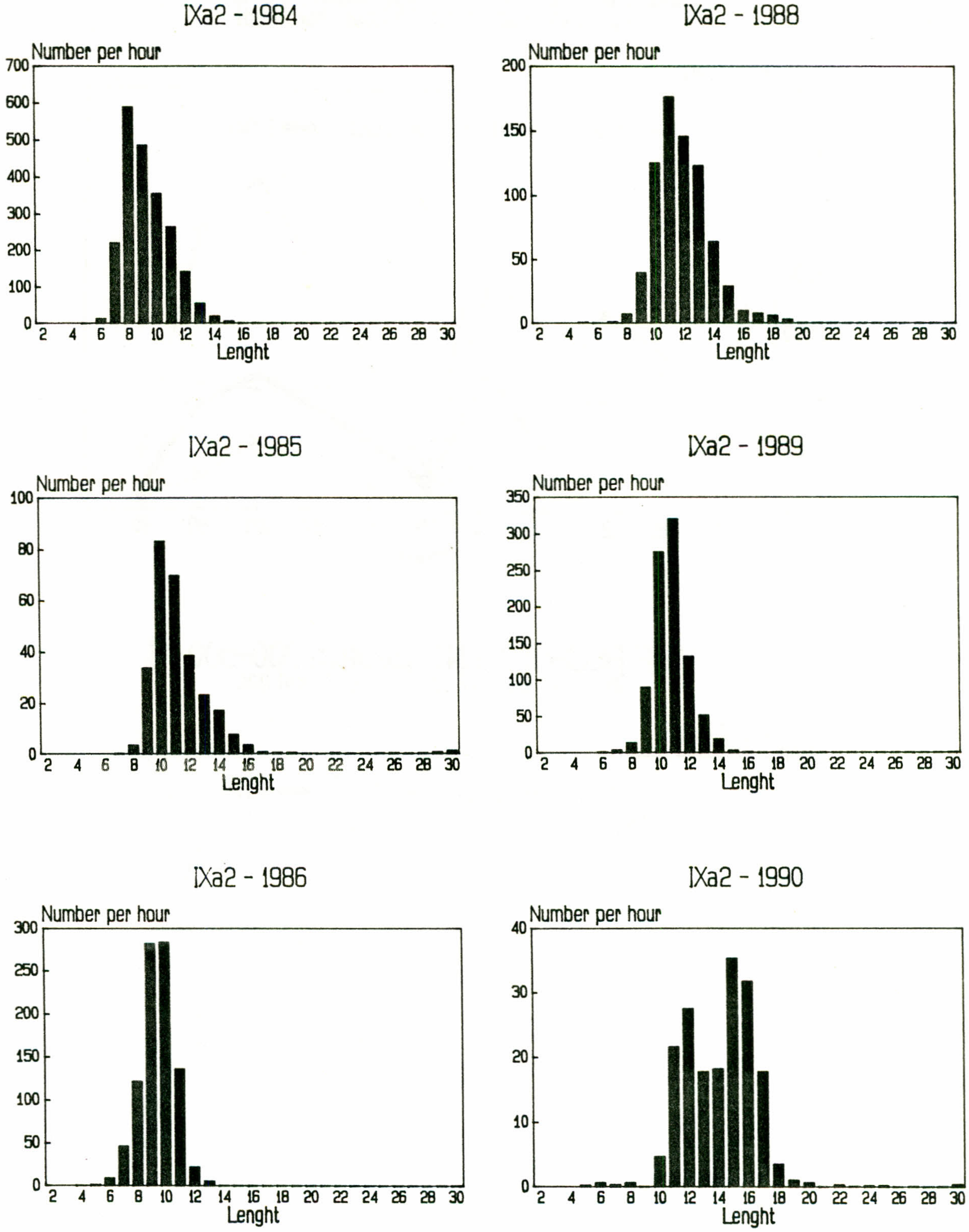


Figure 4.- Length distribution of hake in Subd. IXa2.

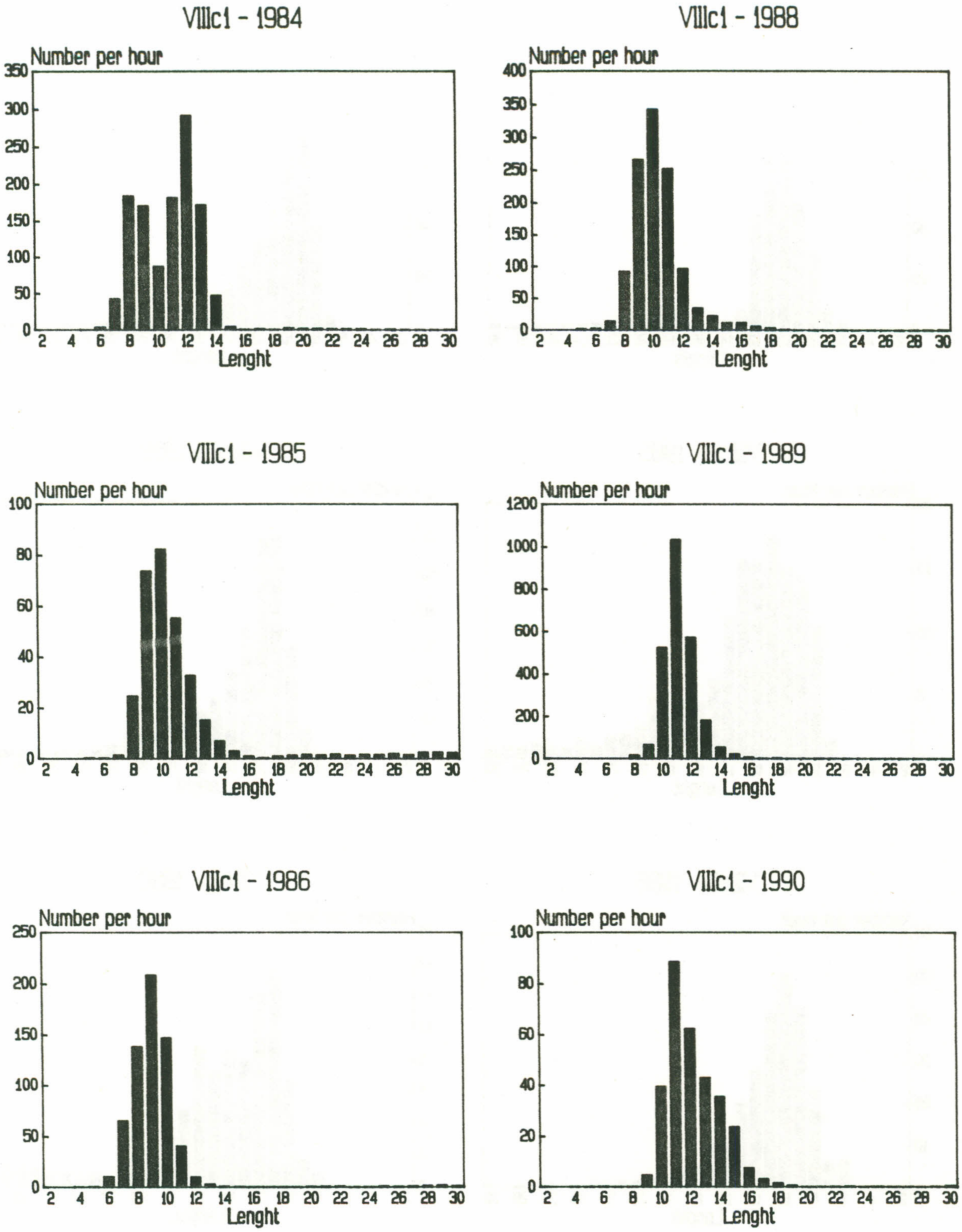


Figure 5.- Length distribution of hake in Subd. VIIIc1.

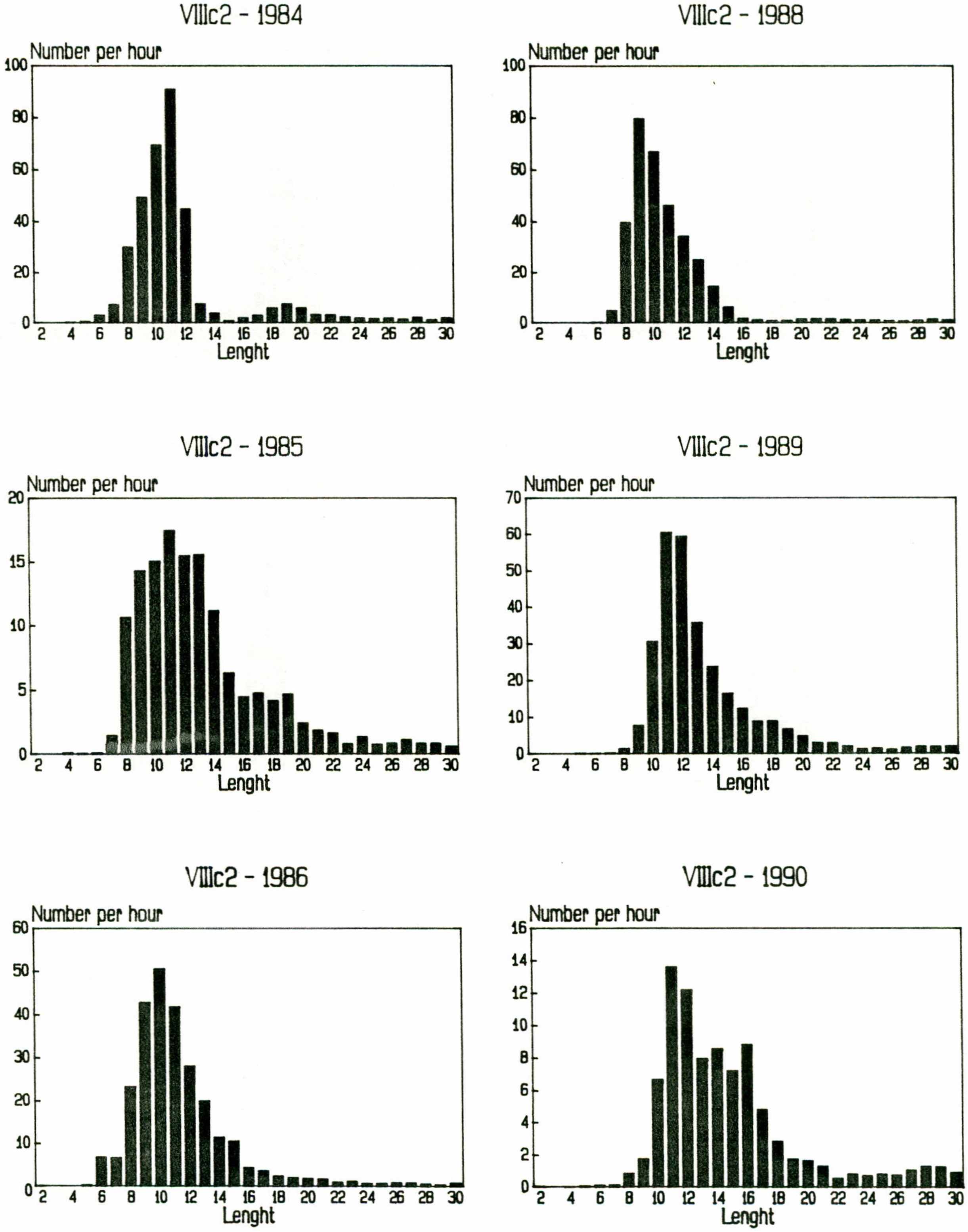
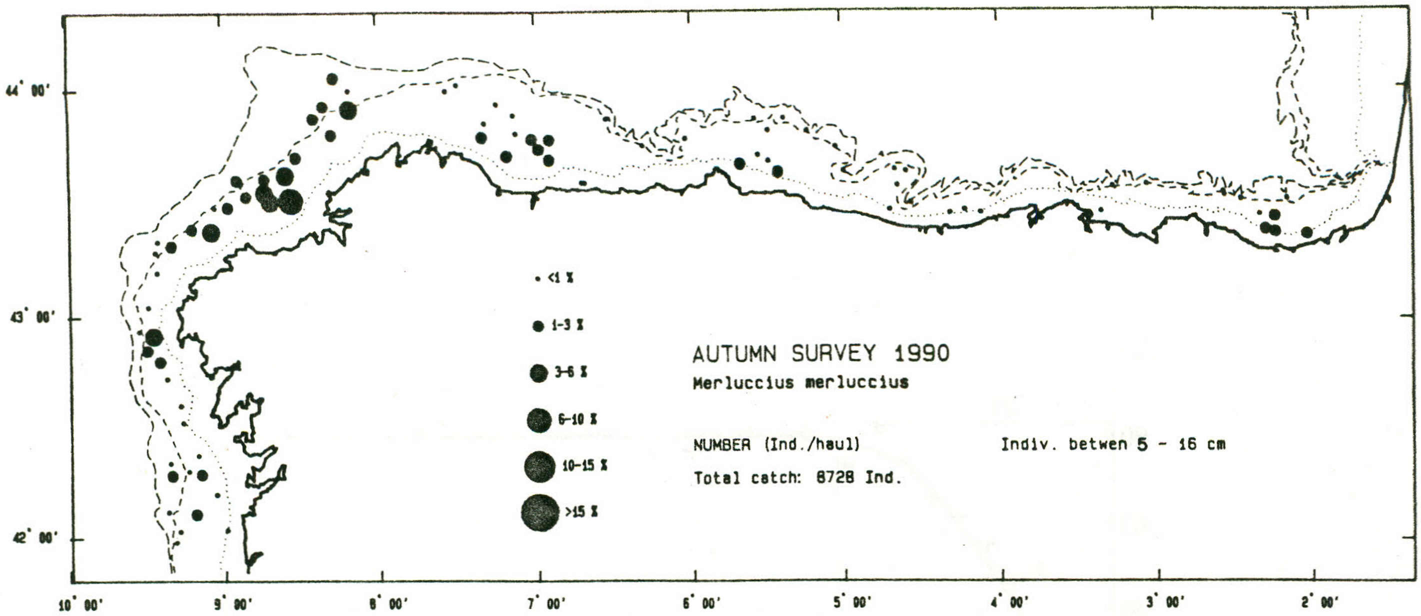
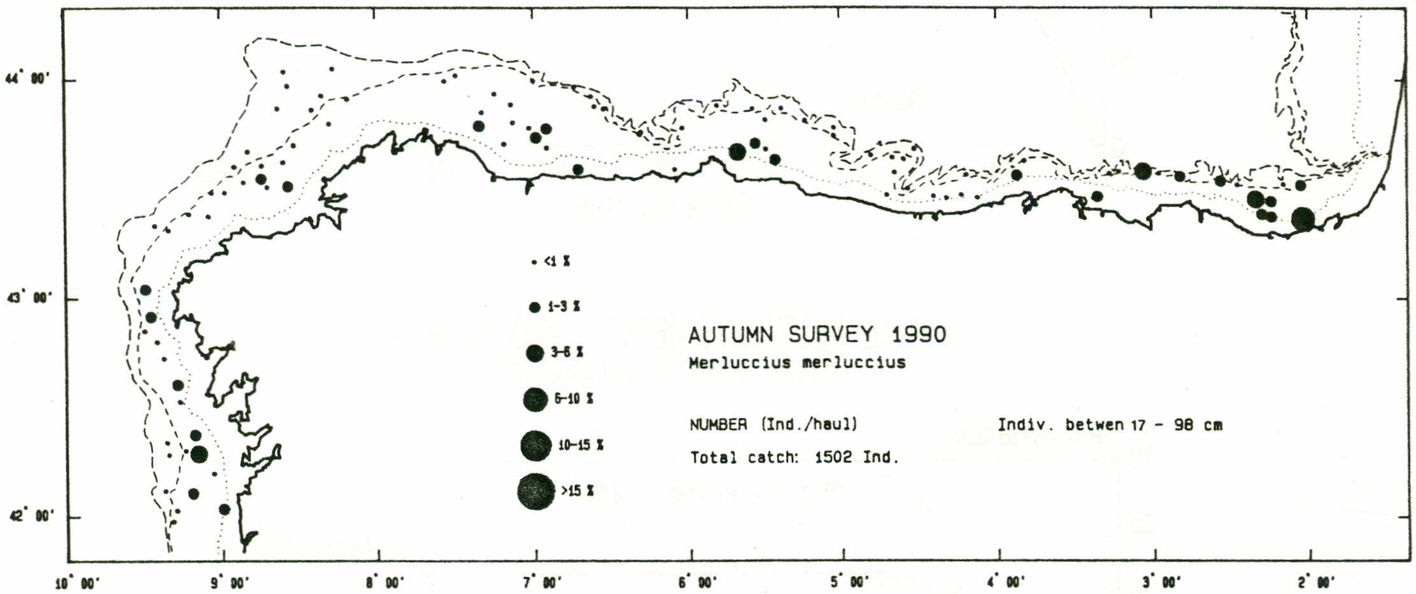


Figure 6.- Length distribution of hake in Subd. VIIIc2.





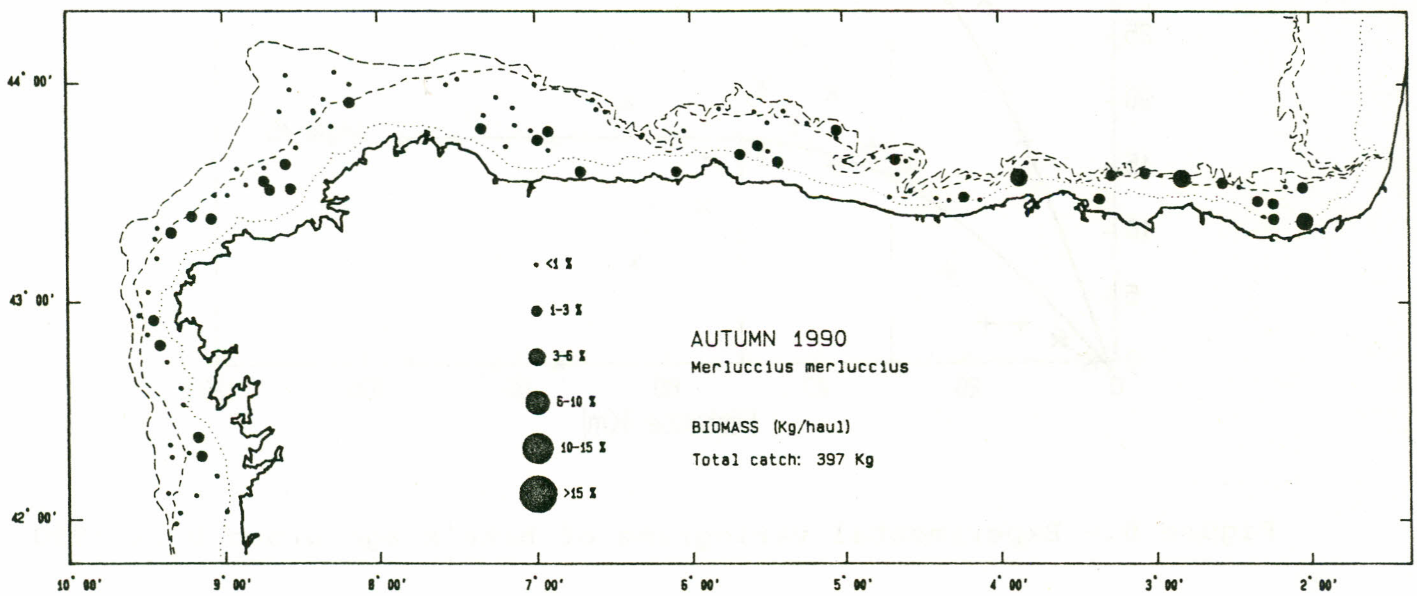
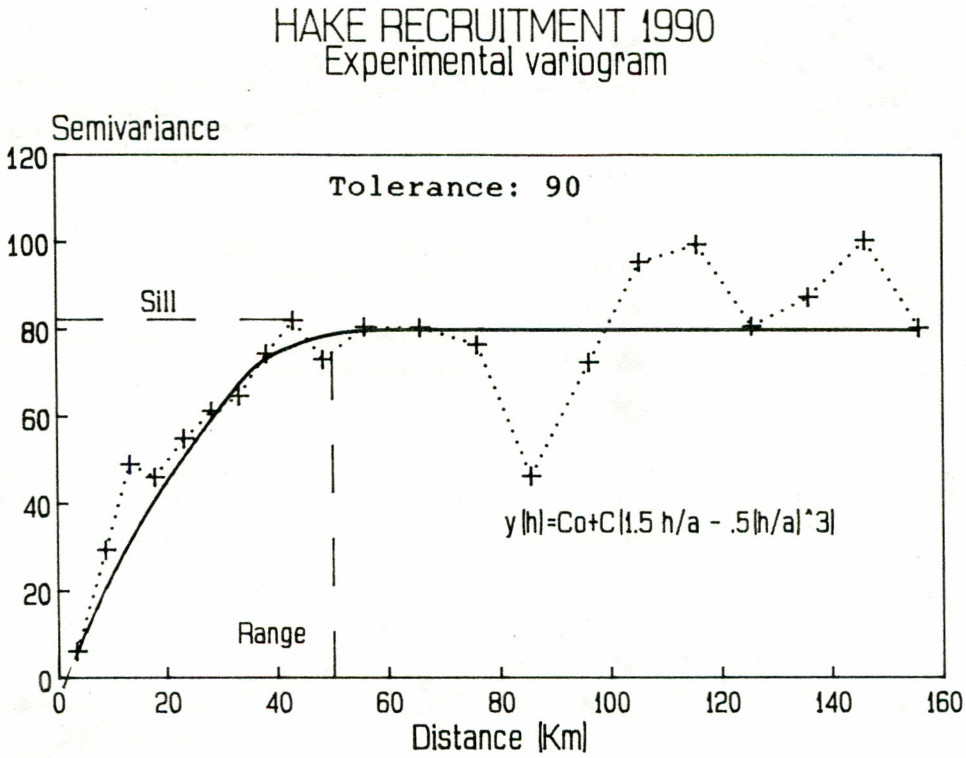


Figure 7.- Spatial distribution of hake during 1990.



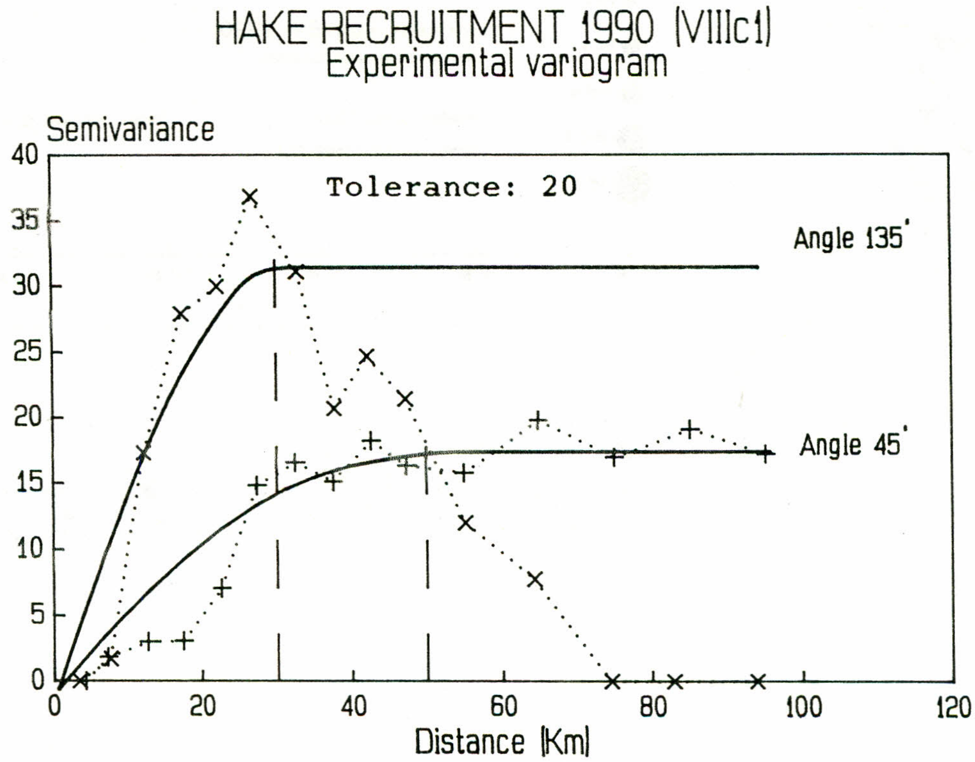


Figure 8.- Experimental variograms of hake's age group 0 in 1990

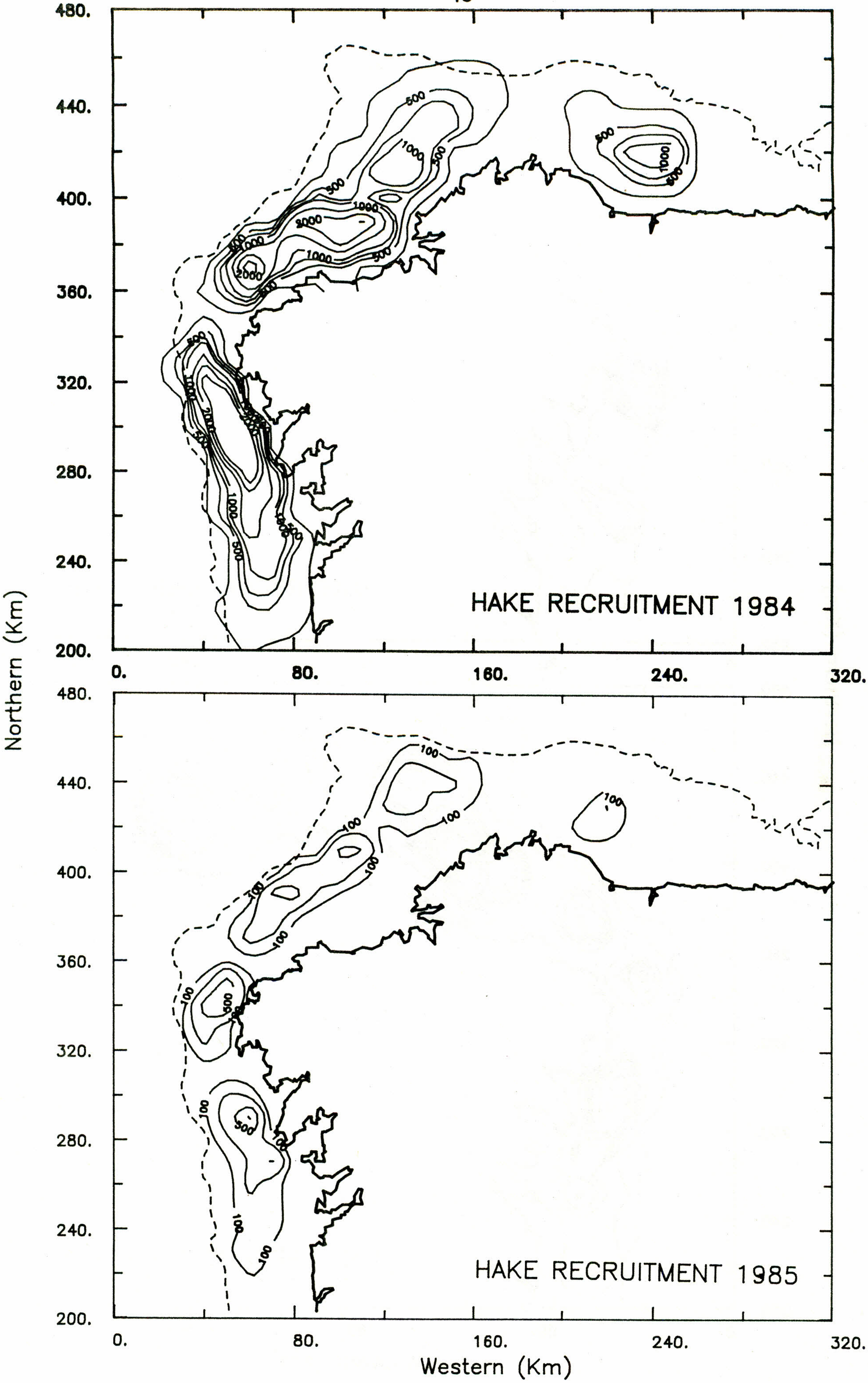


Figure 9.- Kriged map of hake's age group 0 (Ind<17 cm./1 hour trawl) in 1984 and 1985.

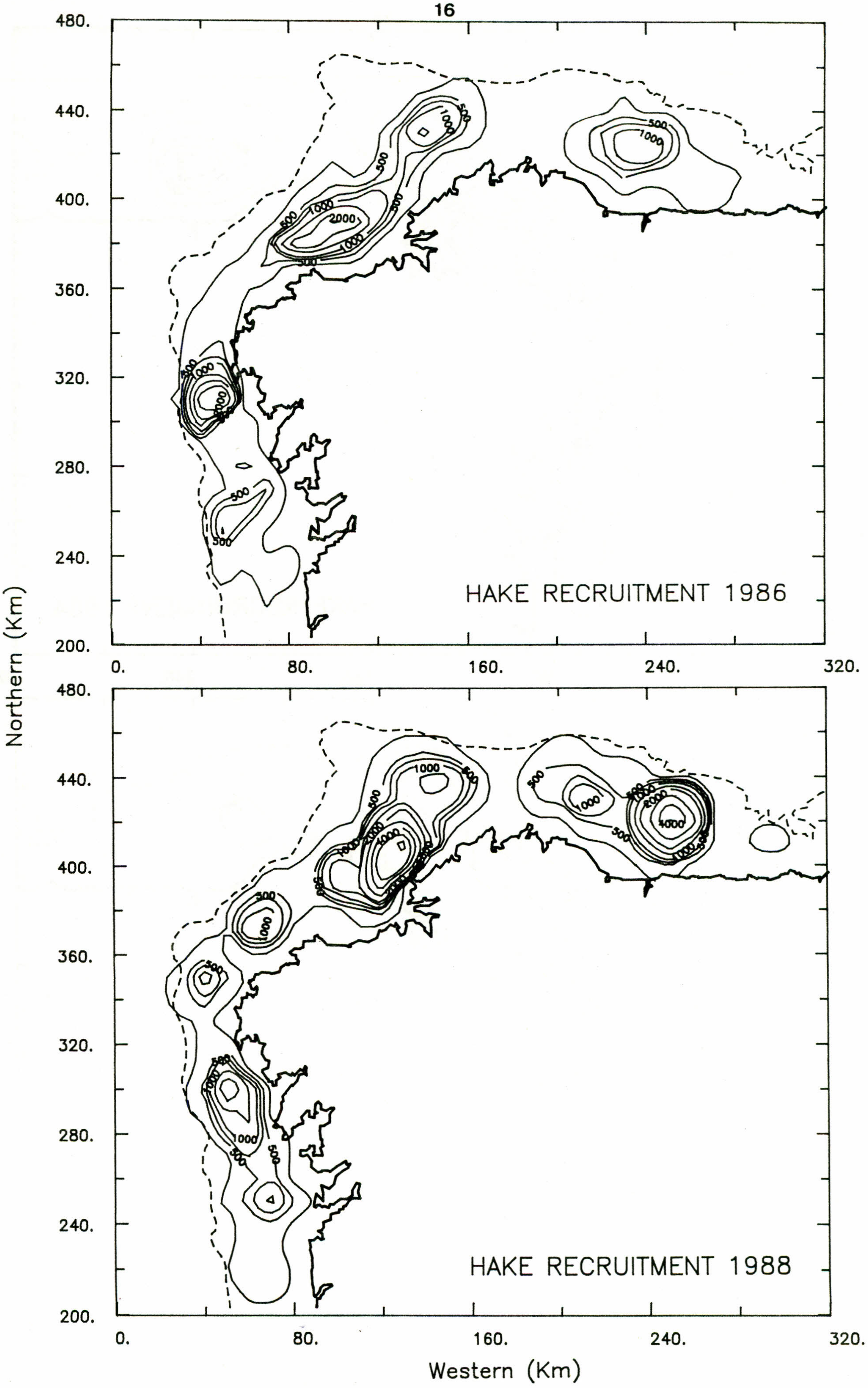


Figure 10.- Kriged map of hake's age group 0 (Ind<17 cm./1 hour trawl) in 1986 and 1988.

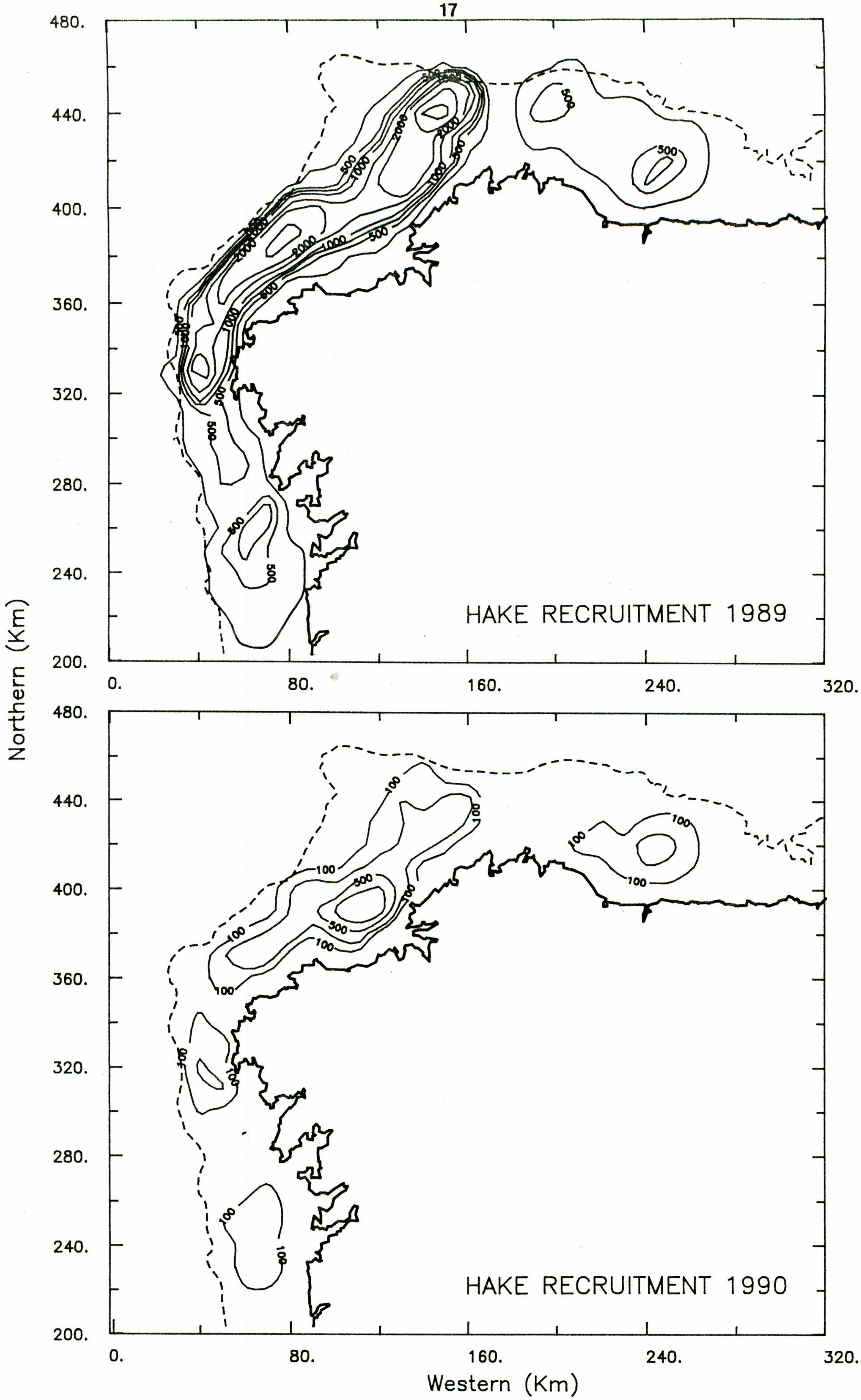


Figure 11.- Kriged map of hake's age group 0 (Ind<17 cm./1 hour trawl) in 1989 and 1990.